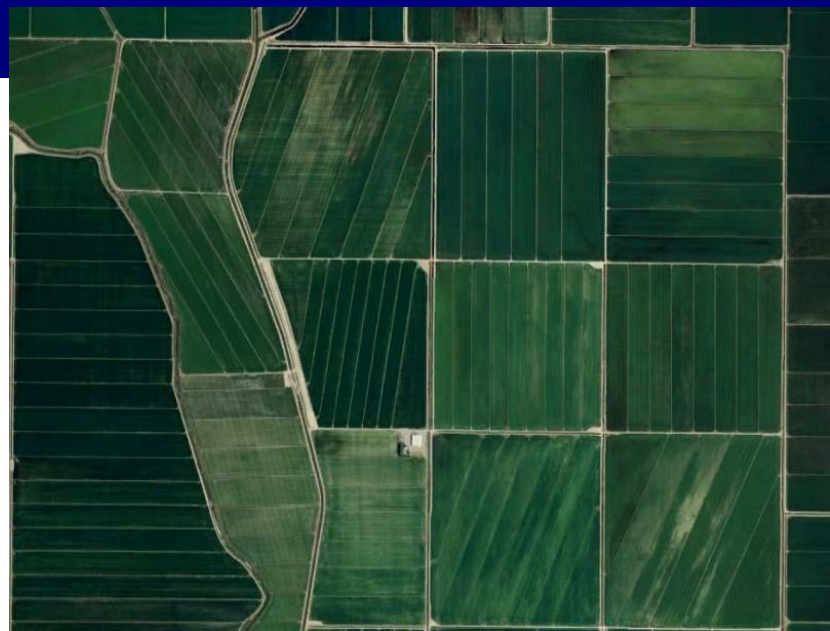
Applying IDC to the Sacramento Valley in Support of the Regional GW Model, SacFEM

November 9, 2011



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Overview

- Project Description & Background
- Modeling Approach
- Calibration Data Set
- Calibration Results
- Post-Calibration
- Validation
- Results

Project Description

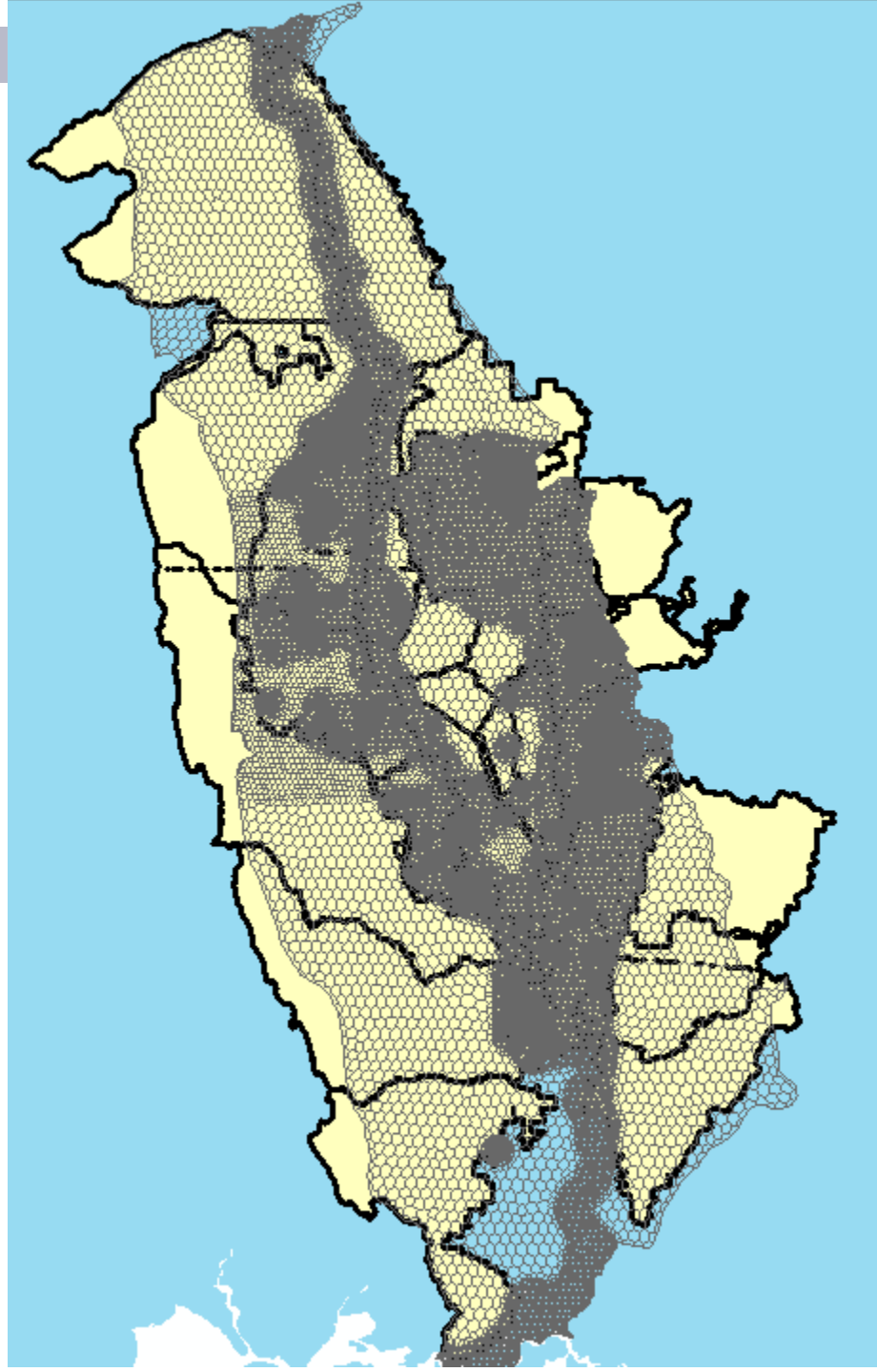
- Use IDC to develop time-series (TS) of deep percolation and groundwater pumping for input into regional groundwater model of Sacramento Valley (SacFEM)
- Update to previous work to revise estimates for certain areas based on detailed water budget data

Project Background

- SacFEM originally developed in 2008 to investigate conjunctive use opportunities in the Sacramento Valley
- MBK used IDC 2.0 to develop TS of deep percolation and groundwater pumping
- TS data are coupled into SacFEM to represent root zone fluxes

SacFEM Model Background

- Finite element model of Sac Valley
  - 120,761 nodes
  - Element size ranges from 2.5 to ~1,500 acres
- WY 1970-2010 simulation period
- Monthly time-step



Modeling Approach

- Fine grid would require large IDC input files, long run times, and potential for many headaches and errors
- Aggregate specific areas of the valley based on location and water source
- Structured IDC to simulate one acre of each land-use/soil type combination within larger water budget areas (WBAs)

Structure of IDC-SacFEM

- Three hydrologic soils group (B,C, & D) and 28 WBAs
  - 252 sub-regions
- 20 land-use categories
  - 16 Non-ponded Crop
  - 3 Ponded Crops
  - 1 Native Vegetation
- 1,680 unit factor TS (WY 1979 to 2010)
  - TS are unique combinations of WBA, soils group, and land use

GIS Processing

- Intersect SacFEM model grid with other data in GIS
  - Water budget areas
  - DWR land use and water source surveys
  - Water district boundaries
  - NRCS soils maps
- Acres by SacFEM node, WBA, land use, soil type, water district
  - ~407,000 GIS records for 120,761 nodes

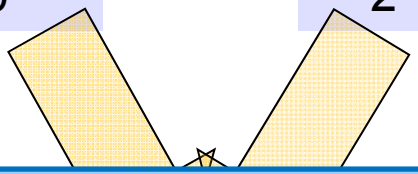
Calculate SacFEM Inputs

TS of unit factors from IDC (ac-ft/ac)

Date	8N_RI_C	8N_RI_D
Jun-95	0.5	0.6
Jul-95	0.7	0.8
Aug-95	0.8	1.0

Table of GIS acreage

Node	WBA_Crop_Soil	Acres
1	8N_RI_C	0.1
1	8N_RI_D	1.5
2	8N_RI_D	1.5



TS of SacFEM Inputs by Node (ac-ft)

Node	Jun-95	Jul-95	Aug-95
1	0.95	1.27	1.58
2	0.90	1.20	1.50

Updates to Original Model

- Update previous model to revise estimates for certain areas based on detailed water budget dataset
- Used latest version of IDC (v. 4.0.143)
  - Ponded crop operations simulated within IDC
- Daily time-step
- Extend simulation period to 2010
- Incorporate soils data

Calibration Data Set

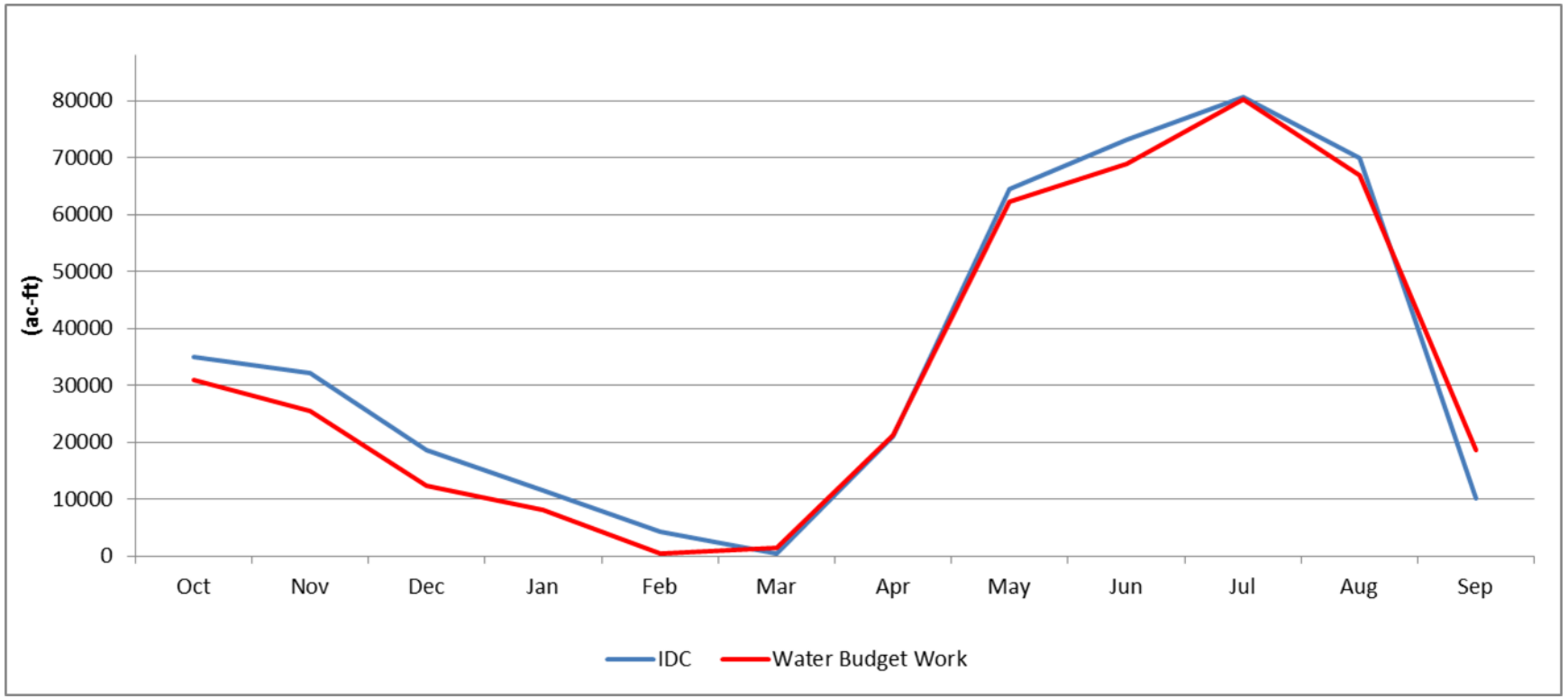
- Detailed water budget dataset for Glenn-Colusa Irrigation District
- Monthly data for 2001-2010 included water budget terms by crop
- Calibrated IDC for two sub-areas by primarily targeting:
  - Applied water demands
  - Deep percolation
  - Runoff
  - Soil storage

Calibration

Flow Terms	Calibration Parameters / Targets
ET	TS of irrigation period
Applied Water	TS of irrigation period, Ponding depths, and Return flow depths
Runoff of Precipitation	Curve Numbers
Return Flow	Return Flow Percentage
Soil Storage	Field Capacity, Rooting Depths
Deep Percolation	Field Capacity, Porosity, Pore Size Distribution Index, and Saturated Hydraulic Conductivity (K_{sat})

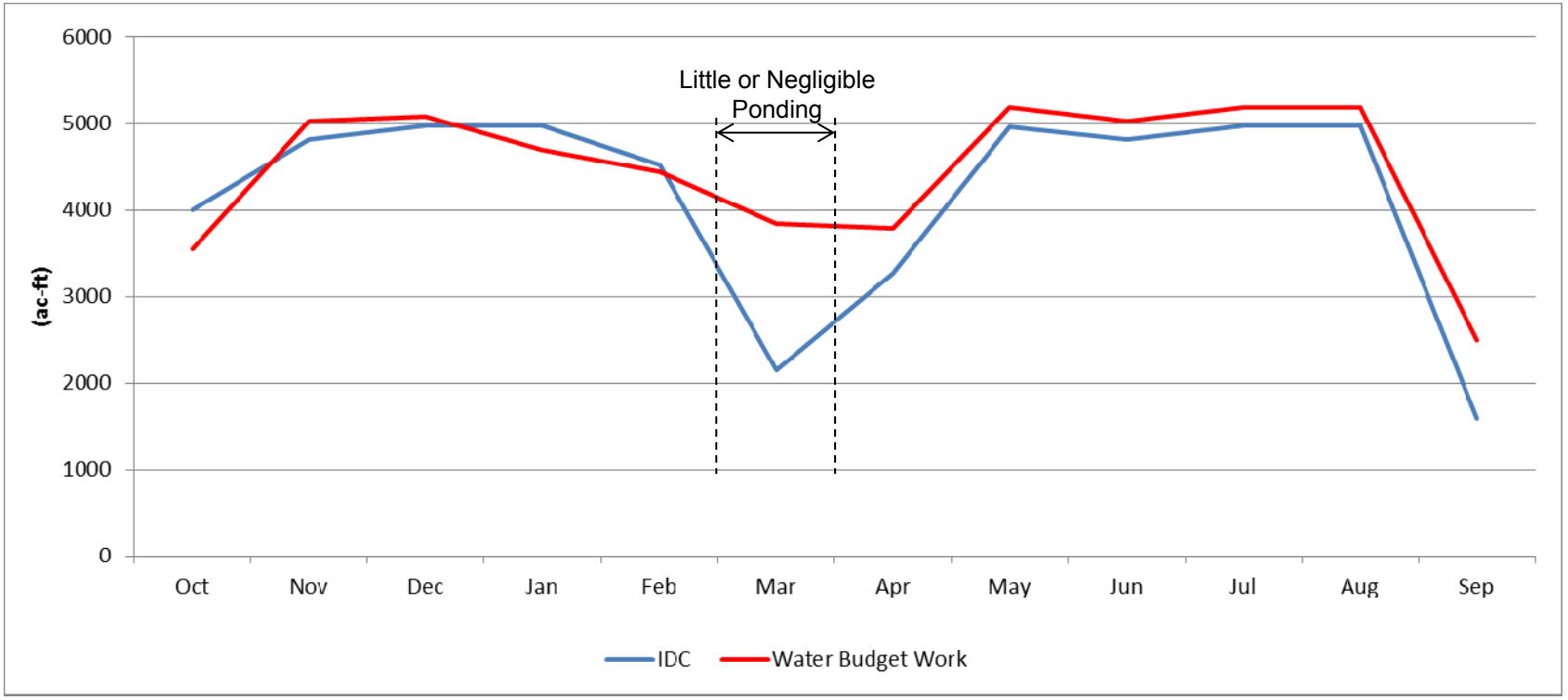
Calibration Results

Average Monthly Total Applied Water
North Sub-Area
(WY 2001 – 2010)



Calibration Results

Average Monthly Total Deep Percolation of Rice Crops
North Sub-Area
(WY 2001 – 2010)

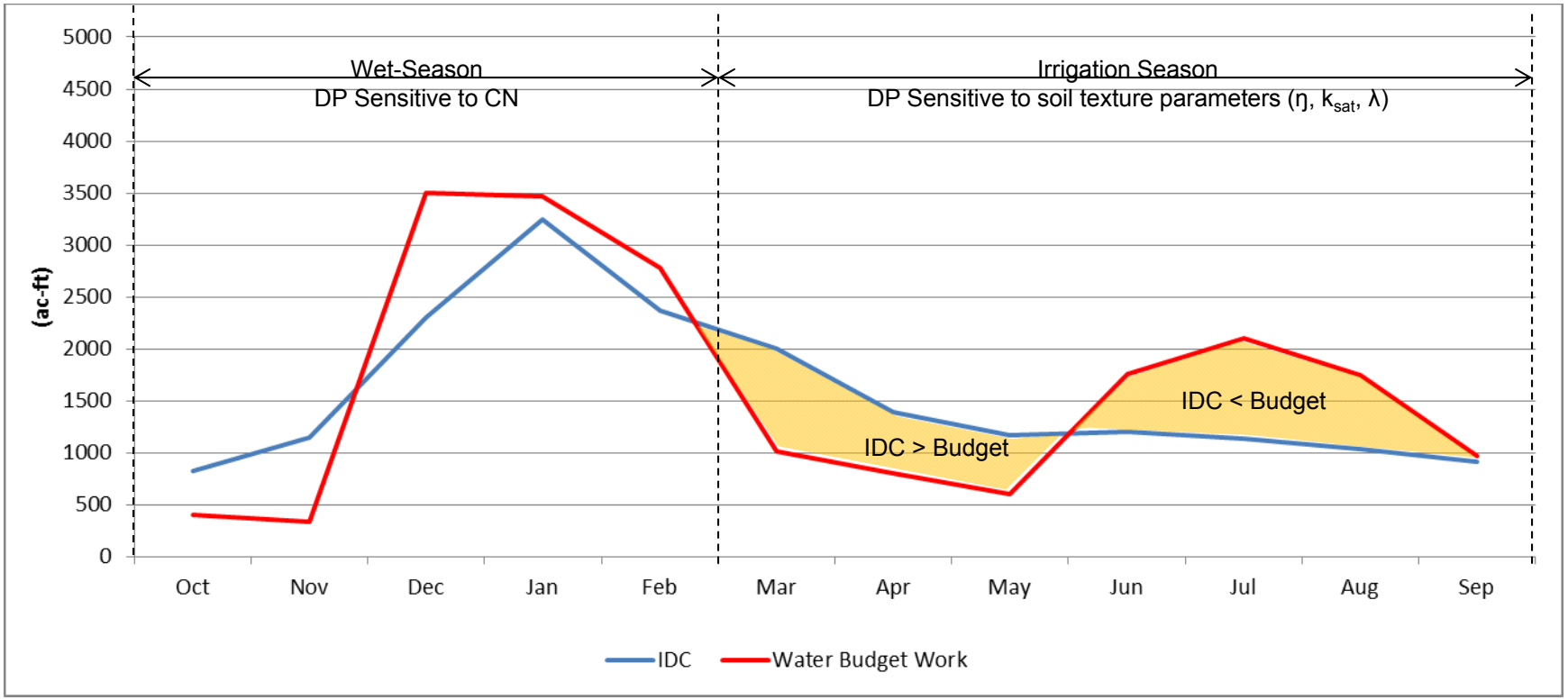


Calibration Results

Average Monthly Total Deep Percolation of Non-Ponded Crops

North Sub-Area

(WY 2001 – 2010)

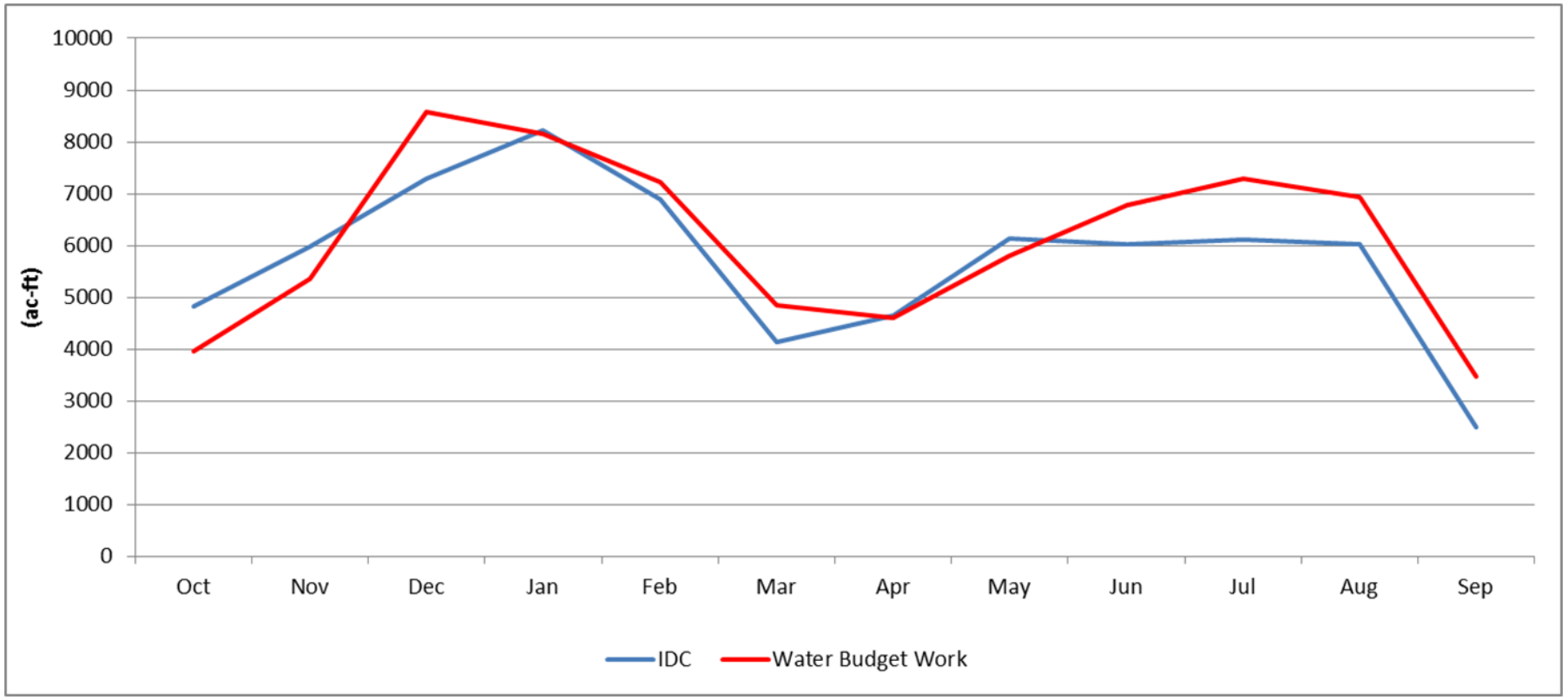


Calibration Results

Average Monthly Total Deep Percolation

North Sub-Area

(WY 2001 – 2010)



From Irrigation District Level to Sac Valley

- Need for extrapolation to HSGs'
- Quantified land-use and HSG data within GCID to understand their area-weighted distribution
- Extrapolate ŋ, k_{sat}, λ, CN with an Area-weighted method with respect to hydrologic soils groups

Area Weighted Extrapolation Example

- For Pasture

		Curve numbers for hydrologic soil group			
Cover Type	Hydrologic Condition	A	B	C	D
Pasture, grassland, or range -- continuous forage for grazing.	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80

Source: Table 2-2c, Chapter 2, Technical Release 55 Urban Hydrology for Small Watersheds

Relative difference		
CN_B-CN_A	CN_C-CN_B	CN_D-CN_C
20	10	5

- Develop area-weighted system of equations
  - $A_{HSGA}(CN_A) + A_{HSGB}(CN_B) + A_{HSGC}(CN_C) + A_{HSGD}(CN_D) = A_{GCID,N}(CN_{GCID,N})$ (1)
- Four unknowns: CN_A, CN_B, CN_C, & CN_D
- Use relative differences between HSGs' to develop last three system of equations

Area-Weighted Extrapolation Example

- Relative Differences that make up the system of Equations (Cont'd)
  - $CN_B - CN_A = 20$ (2)
  - $CN_C - CN_B = 10$ (3)
  - $CN_D - CN_C = 5$ (4)

Relative difference		
$CN_B - CN_A$	$CN_C - CN_B$	$CN_D - CN_C$
20	10	5

- Find the four unknowns: CN_A, CN_B, CN_C, & CN_D with four equations

Findings

- For 252 sub-regions:

Soil Parameters and Inputs (Units)	Range
Porosity (L\L)	0.25 - 0.35
Field Capacity (L\L)	0.15 - 0.2
Pore-size Distribution Index (L\L)	0.3-1.35
Saturated Hydraulic Conductivity (ft\month)	0.05 – 2
Curve Numbers	64 – 84
Ponding Depths (inches per day)	0 – 6

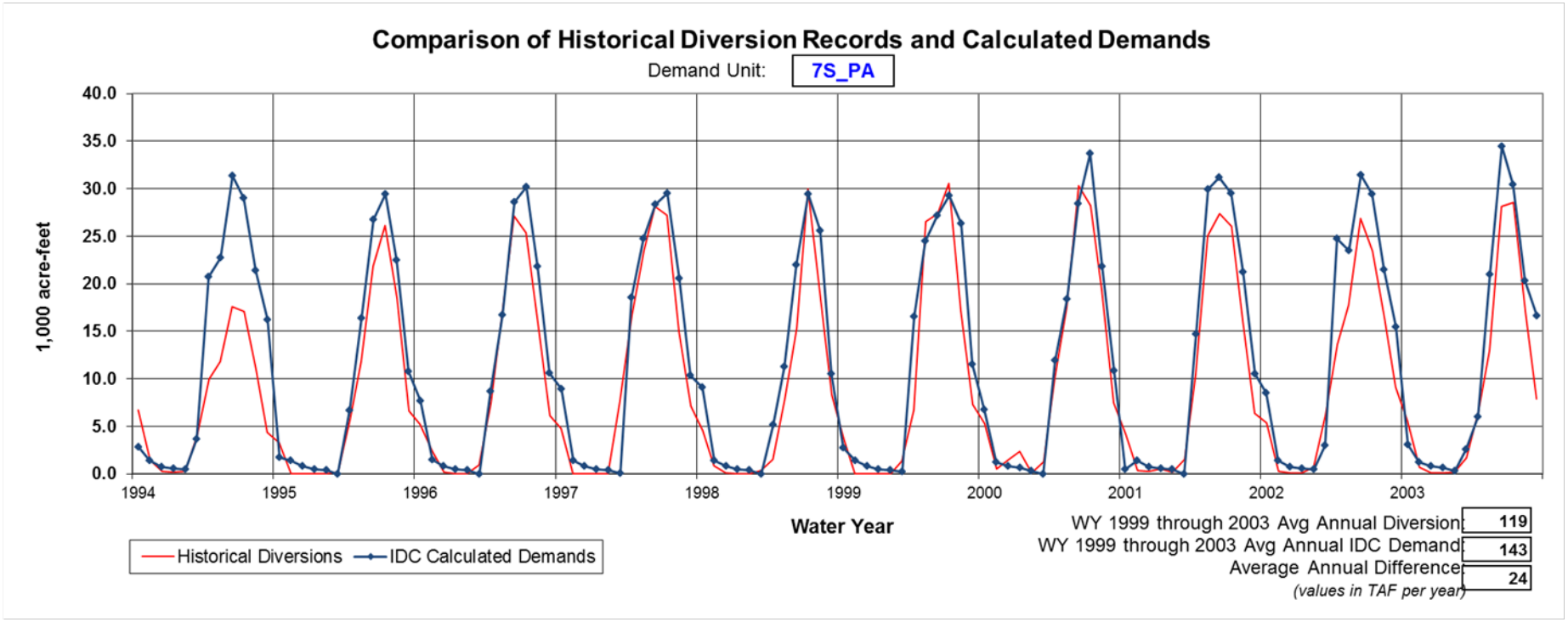
- Run IDC-SacFEM Simulation

Verification

- Compared applied water totals with historical diversion records
- Verified ranges of applied water depths for crops, that is:
- Non-Rice Crops: Between 3’ – 4’ average annual water application
- Rice Crops: Between 6’ – 8’ average annual water application

Verification

- Historical Diversion versus Calculated Demands



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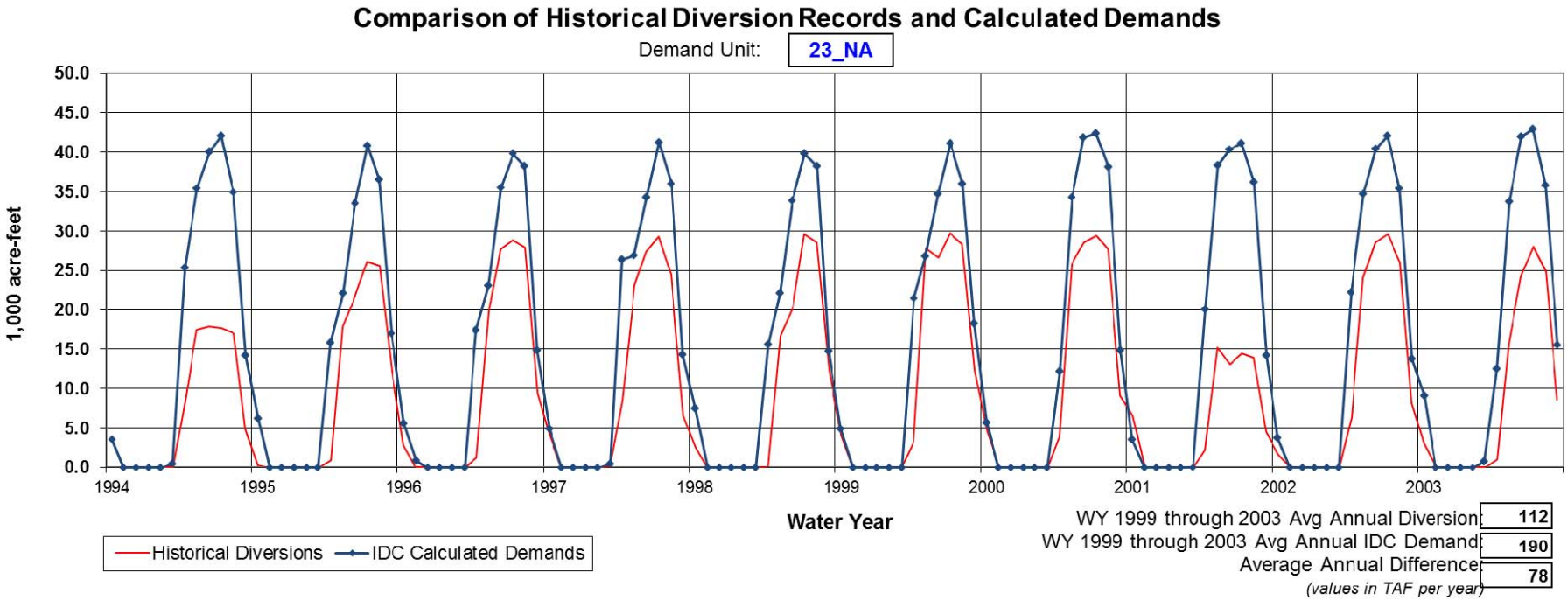

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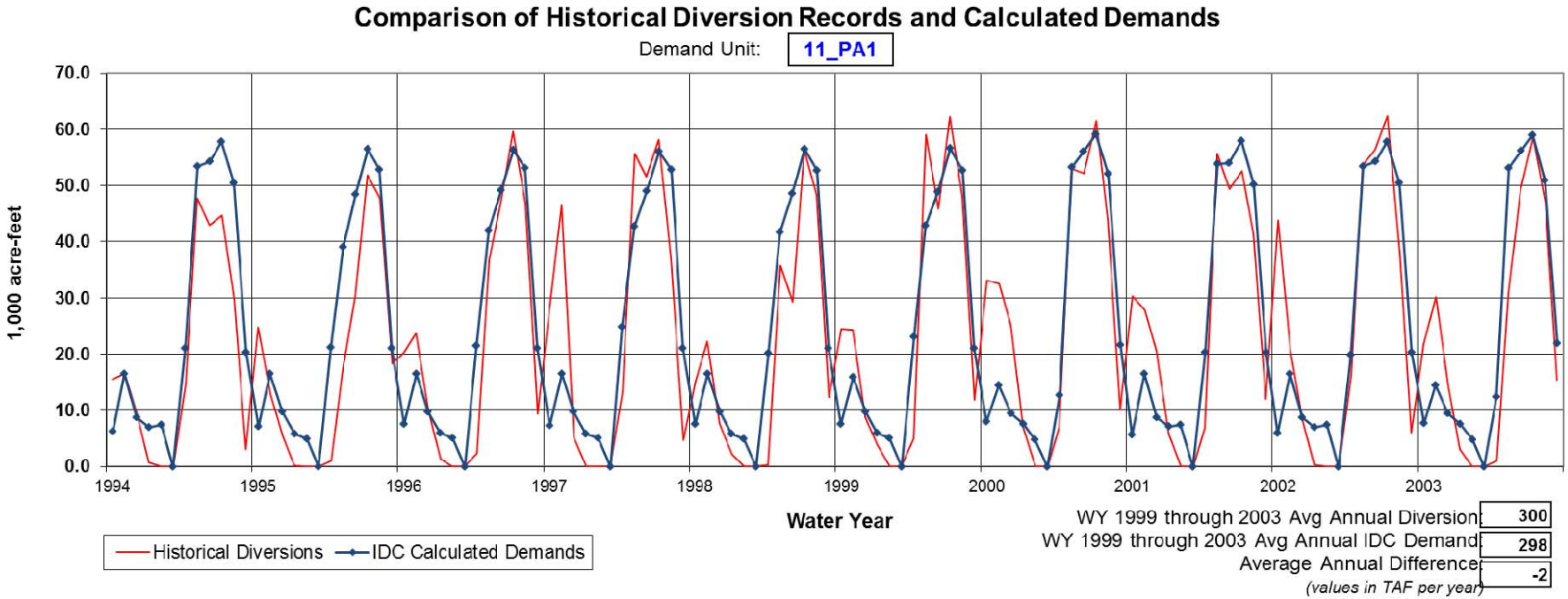

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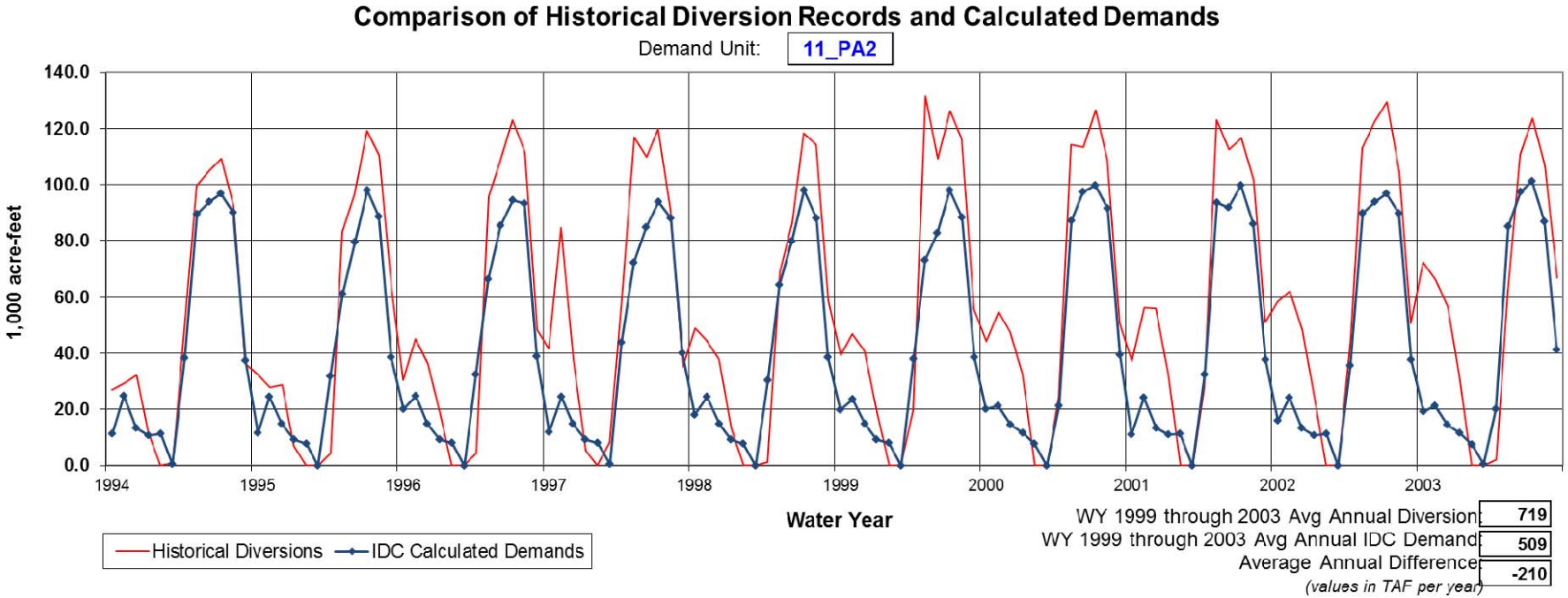

Summary

- Used IDC to create TS of root zone fluxes for regional gw model
- Calibrated IDC soil parameters with water budget data
- Extrapolated IDC inputs to other areas of Sacramento Valley
- Verified results by comparison with other available data

Discussion

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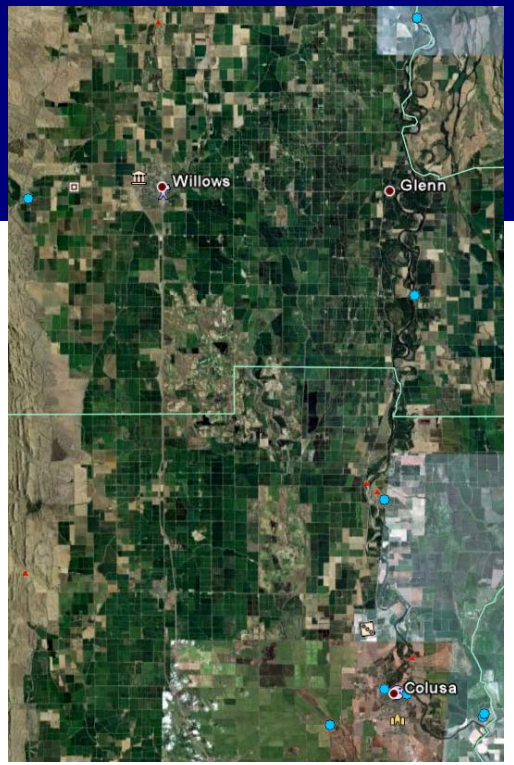

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